FURTHER MEASUREMENTS OF *TRYPANOSOMA RHODESIENSE* AND *T. GAMBIENSE*

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(*Received for publication* 21 *December*, 1912)

In our former paper (May, 1912) on this subject, we came to the conclusion that it was advisable in measuring trypanosomes to confine our observations to those from a single animal, for example, a rat, as although it could not be definitely proved that the size of the trypanosome varied in different animals, yet it appeared likely from the general consensus of opinion that this might be so. From the statistical side the criticism has also been brought that samples of twenty at any particular time are too small. In our present series of measurements therefore, we have, as far as possible, met these objections by measuring always from a single animal, a rat, and by measuring one hundred trypanosomes each day for the first ten days of the infection. We may here briefly repeat our method, as it has been subjected to some criticism.

1. We project the trypanosomes on a screen in a dark room and trace them, instead of drawing them with a camera lucida. It has been objected that this method cannot be used in the wilds of Africa, but we never stated that it could or should, and that is no reason why we should not use it in a laboratory. Our critics might as well object to our using electric light.

2. We measure the trypanosomes by means of the 'tangent line' method. We believe that as this method is the most accurate known—our critics have not attempted to deny this—we are again amply justified in preferring it to the less accurate compass method, even though the difference may be only 1 or 2 μ. It seems to us hardly a matter for argument that if it is worth measuring 1,000 trypanosomes at all, it is worth doing so accurately, especially if length is to be considered a criterion of specificity.

We believe that it is important to give the actual data as to measurements as Bruce does, and not simply averages, as the actual data are necessary for a closer analysis than averages permit. We give first, then, the fundamental data for each trypanosome (*T. rhodesiense* and *T. gambiense*) and the tables compiled from them. We shall subsequently make a comparative analysis of the two sets of figures.

TABLE I.—Distribution in respect to length of 1,000 non-dividing individuals of *Trypanosoma rhodesiense* from a single white rat.

		In Microns																							Averages	
		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	of each 20	of each 100
1st Day ...	1	...	...	...	...	...	...	...	1	2	2	1	1	3	3	4	1	2	...	...	...	...	...	...	26·0	
	2	...	...	...	...	...	1	2	1	2	2	3	1	5	...	3	...	...	...	...	...	...	...	...	24·05	
	3	...	...	...	...	...	1	1	...	2	2	...	2	3	2	3	3	1	...	...	...	...	...	...	25·6	25·14
	4	...	...	...	...	2	1	2	...	1	2	2	1	4	1	1	3	...	...	...	...	...	...	...	24·1	
	5	...	...	...	...	...	...	...	...	1	3	...	6	4	1	2	1	...	2	...	...	...	...	...	25·95	
2nd Day ...	6	...	...	...	...	...	...	1	1	1	3	...	3	2	1	5	3	...	...	...	...	...	...	...	25·65	
	7	...	...	...	...	...	...	...	...	...	2	3	1	5	4	4	1	...	...	...	...	...	...	...	26·1	
	8	...	...	1	2	3	3	2	3	...	...	1	...	3	...	2	...	...	...	...	...	...	...	...	21·1	22·98
	9	...	...	1	...	5	2	1	4	3	1	1	...	1	...	...	...	1	...	...	...	...	...	...	20·85	
	10	...	...	1	...	2	2	4	3	2	2	...	3	1	...	...	...	...	...	...	...	...	...	...	21·2	
3rd Day ...	11	...	...	...	...	...	1	2	1	3	5	1	3	3	1	...	...	...	...	...	...	...	...	...	23·25	
	12	1	...	...	1	...	2	1	3	2	2	3	2	1	2	...	...	...	...	...	...	...	...	...	22·2	
	13	...	...	...	...	1	2	1	3	3	1	4	2	1	1	...	...	1	...	...	...	...	...	...	22·85	22·51
	14	...	...	...	...	...	2	3	4	4	2	2	2	1	...	...	...	...	...	...	...	...	...	...	22·0	
	15	...	...	1	1	...	1	2	4	2	2	4	...	1	...	1	1	...	...	...	...	...	...	...	22·25	
4th Day ...	16	...	...	...	...	1	1	4	1	2	1	1	6	2	...	...	1	...	...	...	...	...	...	...	23·0	
	17	...	...	...	...	3	1	2	3	1	3	3	2	2	...	...	...	...	...	...	...	...	...	...	22·05	
	18	...	...	2	...	2	2	1	5	3	1	2	1	1	...	...	...	...	...	...	...	...	...	...	20·95	22·16
	19	...	...	...	1	1	3	4	4	2	1	1	1	2	...	...	...	...	...	...	...	...	...	...	21·2	
	20	...	...	...	...	...	1	...	3	2	5	...	5	3	...	1	...	...	...	...	...	...	...	...	23·6	
5th Day ...	21	...	...	1	...	2	1	3	...	...	3	5	...	2	2	...	...	1	...	...	...	...	...	...	22·8	
	22	...	...	...	...	...	...	...	3	1	...	3	2	3	5	3	...	...	...	...	...	...	...	...	25·2	
	23	...	...	...	...	...	1	...	2	2	1	2	3	1	1	2	4	...	1	...	...	...	...	...	25·35	24·72
	24	...	...	...	1	...	...	...	1	2	1	4	3	2	1	5	...	...	...	...	...	...	...	...	24·75	

6th Day ...	26	...	...	...	1	...	1	3	1	5	4	4	1	...	...	...	...	...	...	...	...	...	...	...	22·0	
	27	...	...	...	1	...	1	2	2	1	5	1	2	2	3	...	...	...	...	...	...	...	...	...	23·1	
	28	...	...	...	...	1	...	1	...	3	...	5	2	3	4	...	1	...	...	...	...	...	...	...	24·45	24·19
	29	...	...	...	...	...	...	...	1	...	3	3	2	3	2	2	3	1	...	...	...	...	...	...	25·85	
	30	...	...	...	...	...	...	...	1	...	1	5	4	4	...	2	3	...	...	...	...	...	...	...	25·55	
7th Day ...	31	...	...	1	1	8	3	...	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	19·25	
	32	...	...	...	2	3	3	7	1	1	2	1	...	...	...	...	...	...	...	...	...	...	...	...	19·9	
	33	...	...	...	...	1	...	4	4	1	1	2	2	2	1	1	1	...	...	...	...	...	...	...	23·05	21·71
	34	...	...	...	...	...	...	3	3	3	1	5	2	...	2	1	...	...	...	...	...	...	...	...	23·2	
	35	...	...	...	1	...	...	1	4	1	4	3	3	1	1	1	...	...	...	...	...	...	...	...	23·15	
8th Day ...	36	...	1	...	...	...	...	2	...	1	2	1	...	6	2	3	1	...	...	1	...	...	...	...	25·1	
	37	1	...	...	...	...	1	1	...	1	1	3	2	3	1	4	1	1	...	...	...	...	...	...	24·8	
	38	...	...	...	...	1	1	1	...	...	...	2	1	1	1	2	1	1	2	3	3	...	...	...	27·75	26·15
	39	...	...	...	...	...	...	1	1	...	3	3	1	1	...	5	2	2	...	...	1	...	...	...	26·2	
	40	...	...	...	...	...	...	2	2	1	...	...	1	2	1	2	2	2	4	1	...	...	...	...	26·9	
9th Day ...	41	...	...	...	1	...	...	...	1	2	...	1	2	5	3	3	2	...	...	...	...	...	...	...	25·45	
	42	...	...	...	...	...	1	...	1	...	2	1	4	3	3	2	...	1	2	...	...	...	...	...	25·85	
	43	...	...	1	...	1	...	1	...	1	...	1	3	3	4	1	2	...	1	1	...	...	...	...	25·5	25·67
	44	...	...	...	...	...	...	...	...	1	3	1	3	3	4	4	...	1	...	...	...	...	...	...	25·9	
	45	...	1	...	...	...	...	1	...	...	1	2	3	1	5	3	3	...	...	...	...	...	...	...	25·65	
10th Day ...	46	...	...	...	...	1	...	1	...	1	...	2	2	2	5	3	2	...	1	...	...	...	...	...	25·9	
	47	...	...	...	...	...	...	1	1	...	1	4	2	5	1	2	3	...	...	...	...	...	...	...	25·5	
	48	...	...	...	...	...	...	...	...	...	...	3	1	6	3	2	2	2	1	...	...	...	...	...	26·95	25·98
	49	...	...	...	...	...	1	...	2	...	2	4	2	1	1	3	1	3	...	...	...	...	...	...	25·45	
	50	...	...	...	1	...	...	...	...	1	3	...	2	2	5	2	2	1	...	...	1	...	...	...	26·1	
Totals	...	2	2	9	14	38	40	70	78	71	90	106	99	116	79	87	52	21	14	6	5	1	...	...	Average length of 1[illegible] *T. r.* is 24·121 μ	

* These numbers refer to the consecutive groups of twenty trypanosomes, summarised on each line.

TABLE II.—Summary of measurements (in microns) of lengths of 1,000 individuals of *Trypanosoma rhodesiense* from a single white rat.

		Maximum	Minimum	Averages of each 100	Averages of each 20	Range of averages of each 20
	1	30	21		26·0	
	2	28	19		24·05	
1st Day	3	30	19	25·14	25·6	1·95
	4	29	18		24·1	
	5	31	22		25·95	
	6	29	20		25·65	
	7	29	23		26·1	
2nd Day	8	28	16	22·98	21·1	5·25
	9	30	16		20·85	
	10	26	16		21·2	
	11	27	19		23·25	
	12	27	14		22·2	
3rd Day	13	30	18	22·51	22·85	1·25
	14	26	19		22·0	
	15	29	16		22·25	
	16	29	18		23·0	
	17	26	18		22·05	
4th Day	18	26	16	22·16	20·95	2·65
	19	26	17		21·2	
	20	28	19		23·6	
	21	30	16		22·8	
	22	28	21		25·2	
5th Day	23	31	19	24·72	25·35	2·7
	24	28	17		24·75	
	25	34	20		25·5	
	26	25	17		22·0	
	27	27	17		23·1	
6th Day	28	29	18	24·19	24·45	3·85
	29	30	21		25·85	
	30	29	21		25·55	
	31	22	16		19·25	
	32	24	17		19·9	
7th day	33	29	18	21·71	23·05	3·95
	34	28	20		23·2	
	35	28	17		23·15	
	36	32	15		25·1	
	37	30	14		24·8	
8th Day	38	33	18	26·15	27·75	2·95
	39	33	20		26·2	
	40	32	20		26·9	
	41	29	17		25·45	
	42	31	19		25·85	
9th Day	43	32	16	25·67	25·5	0·45
	44	30	22		25·9	
	45	29	15		25·65	
	46	31	18		25·9	
	47	29	20		25·5	
10th Day	48	31	24	25·98	26·95	1·45
	49	30	19		25·45	
	50	33	17		26·1	
					Range = 27·75—19·25 = 8·5	

Table III.—*T. rhodesiense*, in which the trypanosomes are arranged in Bruce's three groups (*a*) 13-21μ ; (*b*) 22-24μ ; (*c*) 25μ and upwards.

Day		1	2	3	4	5	6	7	8	9	10	Totals
Stumpy ...	13–21μ	12	41	37	45	17	16	53	15	9	8	253
Intermediate	22–24μ	25	19	40	28	31	40	29	18	16	21	267
Long ...	25–36μ	63	40	23	27	52	44	18	67	75	71	480
		100	100	100	100	100	100	100	100	100	100	1,000

This table shows very clearly what we have already pointed out, namely, the great variation in the figures for each group on particular days. Thus on the tenth day there were 8 % of stumpy forms, while on the seventh day there were 53 %. This seems to us to make it perfectly obvious that when a sample is taken at random from an animal on any day an erratic factor is introduced.

We proceed to represent the preceding results graphically.

Chart I shows a curve of measurement of *Trypanosoma rhodesiense*. The distribution, by percentages in respect to length, of the 1,000 non-dividing specimens of the trypanosome is plotted. The parasites were taken from the peripheral blood of a rat. One hundred trypanosomes were measured each day for ten consecutive days of infection (vide Table I).

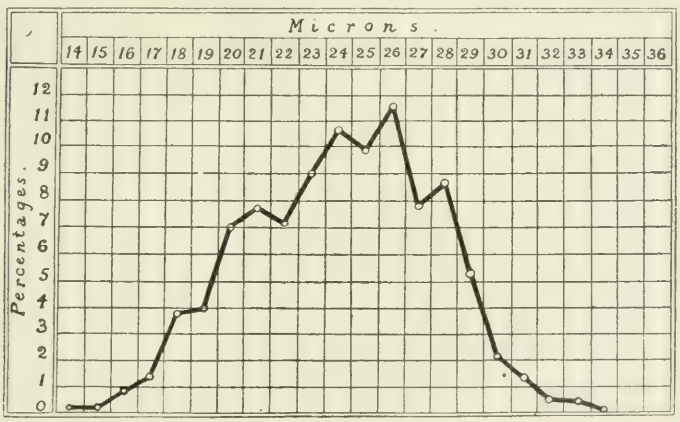


Chart I.—Graphical representation of the distribution of the lengths of 1,000 *T. rhodesiense* from one rat.

We next proceed to give corresponding tables for *T. gambiense*.

TABLE IV.—Distribution in respect to length of 1 000 non-dividing individuals of *Trypanosoma gambiense* from a single white rat.

		In Microns																							Averages	
		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	of each 20	of each 100
1st Day ...	1	...	...	...	1	1	1	2	1	5	...	5	1	2	1	...	...	...	...	...	...	...	...	...	22·45	
	2	...	...	...	...	...	...	...	1	3	3	5	3	2	1	...	...	1	...	1	...	...	...	...	24·6	
	3	...	...	...	...	1	1	3	3	6	...	2	2	...	1	1	...	...	...	...	...	...	...	...	22·25	24·16
	4	...	...	...	...	...	...	...	...	2	...	3	4	2	3	1	5	...	...	...	...	...	...	...	26·1	
	5	...	...	...	...	...	...	...	2	2	2	2	1	3	3	1	4	...	...	...	...	...	...	...	25·4	
2nd Day ...	6	...	...	...	...	...	...	...	...	2	3	2	1	1	1	3	3	1	2	1	...	...	...	...	26·7	
	7	...	...	...	1	...	...	...	...	...	...	1	3	6	2	4	2	...	1	...	...	...	...	...	26·35	
	8	...	...	...	...	...	...	...	...	...	...	3	...	5	4	4	3	1	...	...	...	...	...	...	26·95	26·65
	9	...	...	...	...	...	...	...	...	1	1	...	8	...	4	4	1	1	...	...	...	...	...	...	26·2	
	10	...	...	...	...	...	...	...	...	...	2	1	1	3	4	2	6	1	...	...	...	...	...	...	27·05	
3rd Day ...	11	...	...	...	...	1	...	...	3	1	2	2	5	2	2	...	2	...	...	...	...	...	...	...	24·3	
	12	...	...	...	1	...	...	2	1	1	...	4	4	3	1	...	1	...	1	1	...	...	...	...	24·65	
	13	...	...	1	1	...	1	2	5	2	2	3	...	1	1	1	...	...	...	...	...	...	...	...	22·0	24·14
	14	...	...	...	1	...	...	1	3	3	4	2	1	...	3	2	...	...	...	...	...	...	...	...	23·4	
	15	...	...	...	...	...	...	...	2	...	2	1	3	1	3	1	5	2	...	...	...	...	...	...	26·35	
4th Day ...	16	...	...	...	...	...	...	...	2	2	1	3	2	1	1	2	1	...	1	1	1	1	...	1	26·75	
	17	...	...	...	...	...	...	...	1	2	...	1	...	1	4	3	5	...	3	...	...	...	...	...	27·25	
	18	...	...	...	...	...	1	...	1	...	3	3	2	2	3	3	1	1	...	...	...	...	...	...	25·35	26·42
	19	...	...	...	...	...	...	...	2	1	1	1	1	...	2	5	2	1	3	1	...	...	...	...	27·15	
	20	...	...	...	...	...	...	...	3	2	...	3	4	1	...	1	3	2	...	1	...	...	...	...	25·6	
5th Day ...	21	...	...	...	...	...	2	3	3	1	7	2	1	1	...	...	...	...	...	...	...	...	...	...	22·15	
	22	...	...	1	...	...	...	...	3	1	1	2	4	4	1	2	1	...	...	...	...	...	...	...	24·4	
	23	...	...	...	...	...	...	1	...	2	2	4	3	4	3	...	1	...	...	...	...	...	...	...	24·75	23·87
	24	...	...	...	...	...	1	...	2	2	2	4	2	2	2	1	1	...	1	...	...	...	...	...	24·55	
	25	...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

6th Day ...	26	...	...	...	...	...	...	2	...	1	6	3	1	5	...	...	1	...	...	1	...	...	...	...	[illegible]	
	27	...	...	...	1	...	...	2	2	3	4	3	2	3	...	...	...	...	...	...	...	...	...	...	22·85	
	28	...	...	...	...	...	1	1	1	4	6	2	1	1	2	1	...	...	...	...	...	...	...	...	23·35	22·88
	29	...	...	...	1	2	...	2	4	3	5	...	...	...	2	1	...	...	...	...	...	...	...	...	22·0	
	30	...	...	...	...	...	2	5	3	1	4	4	1	...	...	...	...	...	...	...	...	...	...	...	21·8	
7th Day ...	31	...	...	1	...	1	1	4	1	3	5	2	2	...	...	...	...	...	...	...	...	...	...	...	21·65	
	32	...	...	...	...	1	4	1	4	3	5	2	...	...	...	...	...	...	...	...	...	...	...	...	21·35	
	33	...	...	...	2	1	4	3	2	3	...	...	3	2	...	...	...	...	...	...	...	...	...	...	21·15	21·07
	34	...	...	1	...	1	2	7	3	1	3	...	...	1	1	...	...	...	...	...	...	...	...	...	20·95	
	35	...	...	1	2	3	3	2	2	3	3	...	...	...	1	...	...	...	...	...	...	...	...	...	20·25	
8th Day ...	36	...	...	...	...	...	...	1	1	...	...	1	3	6	3	3	1	1	...	...	...	...	...	...	26·0	
	37	...	...	...	...	...	...	1	...	2	...	1	3	5	5	1	1	...	1	...	...	...	...	...	25·8	
	38	...	...	...	...	...	...	...	...	2	...	2	3	2	1	2	3	4	1	...	...	...	...	...	27·0	26·37
	39	...	...	...	...	...	...	...	1	1	...	1	2	1	1	2	7	1	2	1	...	...	...	...	27·65	
	40	...	...	...	...	...	...	1	1	1	4	...	2	2	5	...	4	...	...	...	...	...	...	...	25·4	
9th Day ...	41	...	...	...	...	...	...	...	1	1	1	2	5	3	1	4	2	...	...	...	...	...	...	...	25·7	
	42	...	...	...	...	...	1	...	...	3	...	2	1	2	2	3	3	3	...	...	...	...	...	...	26·25	
	43	...	...	...	...	...	...	...	1	...	2	4	2	5	3	1	1	...	...	1	...	...	...	...	25·65	26·17
	44	...	...	...	...	1	...	...	1	2	...	...	4	1	3	4	3	1	...	...	...	...	...	...	25·95	
	45	...	...	...	...	...	...	...	...	1	...	2	1	3	3	5	2	1	1	...	1	...	...	...	27·3	
10th Day ...	46	...	...	...	...	...	1	...	...	1	...	...	2	3	1	2	4	5	...	1	...	...	...	...	27·5	
	47	...	...	...	...	...	...	...	1	1	...	...	...	3	1	6	6	1	...	...	...	1	...	...	27·7	
	48	...	...	...	1	...	1	1	...	...	...	4	...	1	2	1	3	3	2	1	...	...	...	...	26·55	26·94
	49	...	...	...	1	...	...	1	1	...	2	1	3	1	3	1	1	3	1	1	...	...	...	...	26·[illegible]	
	50	...	...	...	...	...	...	...	1	1	1	1	1	5	2	1	2	3	1	...	1	...	...	...	26·95	
Totals	...	...	...	5	13	16	28	49	71	84	89	97	100	105	95	80	91	38	21	12	3	2	0	1	Average length of 1000 *T.g.* is 24·867 μ	

TABLE V.—Summary of measurements (in microns) of lengths of 1,000 individuals of *T. gambiense* from a single white rat

		Maximum	Minimum	Averages of each 100	Averages of each 20	Range of averages of each 20
1st Day	1	27	17	24·16	22·45	3·85
	2	32	21		24·6	
	3	28	18		22·25	
	4	29	22		26·1	
	5	29	21		25·4	
2nd Day	6	32	22	26·65	26·7	0·85
	7	31	17		26·35	
	8	30	24		26·95	
	9	30	22		26·2	
	10	30	23		27·05	
3rd Day	11	29	18	24·14	24·3	4·35
	12	32	17		24·65	
	13	28	16		22·0	
	14	28	17		23·4	
	15	30	21		26·35	
4th Day	16	36	21	26·42	26·75	1·9
	17	31	21		27·25	
	18	30	19		25·35	
	19	32	21		27·15	
	20	32	21		25·6	
5th Day	21	26	19	23·87	22·15	2·6
	22	29	16		24·4	
	23	29	20		24·75	
	24	31	19		24·55	
	25	30	18		23·5	
6th Day	26	32	20	22·88	24·4	2·6
	27	26	17		22·85	
	28	28	19		23·35	
	29	28	17		22·0	
	30	25	19		21·8	
7th Day	31	25	16	21·07	21·65	1·4
	32	24	18		21·35	
	33	26	17		21·15	
	34	27	16		20·95	
	35	27	16		20·25	
8th Day	36	30	20	26·37	26·0	2·25
	37	31	20		25·8	
	38	31	22		27·0	
	39	32	21		27·65	
	40	29	20		25·4	
9th Day	41	29	21	26·17	25·7	1·65
	42	30	19		26·25	
	43	32	21		25·65	
	44	30	18		25·95	
	45	33	22		27·3	
10th Day	46	32	19	26·94	27·5	1·7
	47	34	21		27·7	
	48	32	17		26·55	
	49	32	17		26·00	
	50	33	21		26·95	
					Range = 27·7—20·25 = 7·45	

Table VI.—*T. gambiense*, in which the trypanosomes are arranged in Bruce's three groups.

Day	1	2	3	4	5	6	7	8	9	10	Totals
Stumpy ... 13–21μ	17	1	25	10	23	29	57	6	5	9	182
Intermediate 22–24μ	40	16	29	23	33	49	33	15	20	12	270
Long ... 25–36μ	43	83	46	67	44	22	10	79	75	79	548
	100	100	100	100	100	100	100	100	100	100	1,000

Here again we note a great variation in the figures for each group, for example, on the second day 1 % of stumpy forms, and on the seventh day 57 %. The differences are due, according to some authors, to a cycle in the vertebrate host.

In Chart II we give a curve representing the distribution, by percentages in respect to length, of the 1,000 non-dividing specimens of *Trypanosoma gambiense*, taken from a rat. One hundred trypanosomes were measured each day for ten consecutive days of infection (*vide* Table IV).

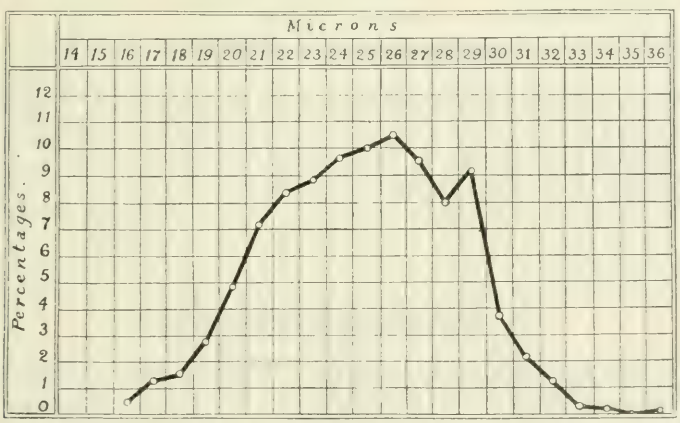


Chart II.—Graphical representation of the distribution of the lengths of 1,000 *T. gambiense* from one rat.

Comparing now *T. gambiense* and *T. rhodesiense* we get the following tables.

TABLE VII

	Average length	Maximum	Minimum
T. gambiense	24·87μ	36·0μ	16·0μ
T. rhodesiense	24·12μ	34·0μ	14·0μ

TABLE VIII.—Comparison of distribution of the trypanosomes according to Bruce's groups.

	13—21μ	22—24μ	25μ and upwards
T. gambiense	18·2 %	27·0 %	54·8 %
T. rhodesiense	25·3 %	26·7 %	48·0 %

TABLE IX.—Distribution by Octiles of both *T. gambiense* and *T. rhodesiense.*

	125th	250th	375th	500th	625th	750th	875th
T. gambiense	21μ	22μ	24μ	25μ	26μ	27μ	29μ
T. rhodesiense	20μ	21μ	23μ	24μ	26μ	27μ	28μ

DISCUSSION OF RESULTS

The fact that we are dealing with a dimorphic trypanosome, the dimorphic nature of which is not thoroughly understood, is no doubt responsible for the difference of opinion as to procedure and for the different results obtained. Such difficulties probably do not arise in the case of a monomorphic trypanosome.

I. THE SIZE OF THE SAMPLE

If Tables II and V be examined, it will be found that on one day the average values of five samples of twenty trypanosomes may vary by as much as 4·35μ in the case of *T. gambiense* and by 5·25μ in the case of *T. rhodesiense.* Also the differences between

the average value for a sample of 100 on any particular day and any of the samples of 20 for that day may vary by as much as 2·21μ (third day) in the case of *T. gambiense*, and 3·12μ (second day) in the case of *T. rhodesiense*, but in the majority of cases it is only about 1 μ. From this it may be inferred that a sample of 100 is a fairly reliable one when trypanosomes are plentiful in the blood; it will, however, not be so good a sample as when trypanosomes are scanty.

II. THE INFLUENCE OF THE DAY OF INFECTION

As was indicated clearly in our previous paper, the day of infection in an acute trypanosomiasis (when death ensues in about ten days), such as that with which we have been dealing, is very important in determining whether the trypanosomes are short or long. Thus on examining our results (arranged according to Bruce's groups) in Table VI, we find that stumpy forms vary from 1 % on the second day to 57% on the seventh day, and this variation is, of course, reflected in the average values of 100 for those days, viz., 26·65μ and 21·07μ respectively. Whether these differences occur in so marked a degree in a chronic infection we are not in a position to state.

III. THE INFLUENCE OF THE ANIMAL HOST

As the day is of prime importance, it is impossible to say whether the length of any trypanosome varies markedly in different hosts. So far as we can see, this could only be determined by measuring 1,000 trypanosomes (if this number suffice) from each of the hosts in question. Consequently we consider it is advisable at present to measure from the same species of animal if comparisons are to be of value.

IV. COMPARISON OF OUR RESULTS WITH THOSE OF OTHER OBSERVERS

Curves for *T. rhodesiense* have been constructed by Bruce and his collaborators (1912), by Kinghorn and Yorke (1912), and by ourselves. There is a fair correspondence between those of Bruce and ourselves, but none between those of Kinghorn and Yorke and

ourselves. We cannot, unfortunately, in the present state of our knowledge, explain these differences satisfactorily. We believe that they must be due to difference of method, namely, that other observers have taken different species of animals on a variety of days.

We ourselves have now completed three curves (1) based on 1,000 trypanosomes from various animals, but including 600 from rats; (2) based on 600 trypanosomes from rats alone, where samples of twenty were taken on a variety of days from several rats; and now finally (3) 1,000 trypanosomes comprising 100 a day from one rat for ten days. These three curves have this in common, that each one has its main peak at 26μ. Further, the agreement is most close between curves (2) and (3) based on rats alone.

We have given previously our reasons for believing that the third method is the best, and the agreement that exists between our curves indicates, we believe, the consistency of our method. We must admit that Kinghorn and Yorke's three curves are also consistent, but it is noticeable that in their measurements, though different animals were used, the total number of trypanosomes from each animal was the same in each case. There is further the possibility that trypanosomes direct from the natural vertebrate hosts or the fly have a different character from those that have been maintained in laboratory animals.

CONCLUSION

We must admit that we had hoped to be able to distinguish between the two species, *T. rhodesiense* and *T. gambiense*, by measuring one thousand specimens of each organism. Though these biometric results are not sufficiently conclusive, we think that it is generally admitted that the two species are distinct.

Microscopically, the two trypanosomes are indistinguishable except by the posterior nuclear character of *T. rhodesiense*. We believe that a curve only expresses graphically what the eye can appreciate under the microscope, and that if two trypanosomes cannot be distinguished microscopically, we shall not be able to do so by measuring them. However, provided that further experience enables observers to agree as to the best procedure, it is no doubt

a great advantage to have a correct graphical expression for what is otherwise only an impression, although it may be a quite accurate one. Further, these measurements should not be regarded as useless, as they will undoubtedly form the basis (provided all the protocols are given) for a critical statistical investigation in the future.

We have pleasure in thanking Mr. Walter Stott, Honorary Statistician to the Liverpool School of Tropical Medicine, for kindly examining our figures.

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